STUDY OF LATE EOCENE BIVALVES FROM BUDA HILLS

by

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Abstract

This paper complete our knowledge of Late Eocene bivalves of Buda Hills. The 370 specimens, collected from 5 localities, belong to 21 species of 15 genera. This study was carried out from palaeoecological, palaeobiogeographical and biostratigraphical points of view. The five rock types containing this bivalve assemblage, correspond to four different palaeoecological environments. Ascending in the sequence the bivalve assemblage of different rock types indicates increase of sea depth. Results of palaeobiogeographical studies are in good agreement with survey supposing South Alpine connections. This fauna is typical of Late Eocene age and species confined only to the Middle Eocene or the Oligocene were not recorded.

Introduction

Although the Late Eocene mollusc fauna of Buda Hills has been thoroughly investigated for some 120 years, no compreshensive monograph was published. It was high time to carry out an up-to-date study of this fauna from palaeoecological, palaeobiogeographical and biostratigraphical points of view.

KOCH (1872) gave a description of Várerdő Hill sequence at Solymár and also mentioned its fauna.

HOFMANN's activity (1873) was very important in contributing to the knowledge of bivalves of Buda Hills. He gave the first descriptions of these bivalves while he studied the Paleogene deposits of Buda region.

LŐRENTHEY (1897) dealt mainly with Tertiary crustaceans, but he also published a large list of mollucs.

LŐVY (1928) not only listed the fauna of Martinovics Hill but gave ecological evaluations as well.

BOKOR (1939) investigated the deposits of the western magin of Buda Hills and mentioned eleven bivalve species belonging to Eocene.

There was much less contribution to the knowledge of Late Eocene bivalves of this region later in this century.

In the last few decades DUDICH (1959), MONOSTORI (1965, 1967), WEIN (1977) and KÁZMÉR (1982) investigated the geology, mineralogy, microfacies and tectonics of Upper Eocene formations. BÁLDI (1986) published new data on the sedimentology, the palaeontology and the age of Buda Marl.

Specimens, studied in this paper, are from the Museum of the Hungarian Geological Institute, the Department of Palaeontology of Eötvös Unviersity and from supplementary collections by the author.

Geological setting

According to BALÁZS et al. (1981) the Upper Eocene of Buda Hills belongs to the epicontinental terrigenous-carbonate development. These sediments discordantly overlie on Triassic dolomites, limestones and Middle Eocene Miliolina limestone.

Late Eocene sea transgressed into Buda region in two steps (DUDICH, 1959). The sequence starts with conglomerate and the *Nummulites* – coralline algae – *Discocyclina* limestone gadually took place. Bryozoan Marl covers this limestone (KÁZMÉR, 1982) either with successive transition on the Mátyás Hill or discordantly with basal conlgomerates on the Martinovics Hill. The next unit is Buda Marl, which underlies the following Oligocene sequences or the Neogene and the Quaternary.

The limestone containing *Nummulites fabianii* indicates Priabonian age. According to KOPEK et al. (1969) it is the *N. fabianii* – *Discocyclina* level (no. XIV) of Transdanubian Central Range.

BÁLDI-BEKE (1970) put Bryozoan and Buda Marls into the Insthomolithus recurvus zone of Priabonian on the basis of similar nannoplankton assemblages.

Localities

Studied specimens were derived from five localities *(Fig. 1)*.:

1. Várerdő Hill at Solymár *(Fig. 2)*.
2. Szépvölgy
3. Martinovics Hill
4. Vár Hill
5. Németvölgyi road.

Specimens were collected layer by layer except for the eastern quarry of Mátyás Hill, where the collection was from the scree of the silicified marl. Unfortunately the bulk of the specimens were gathered decades ago without exact identification of the place or the layer. Due to the same reason individuals from Szépvölgy were considered as one unit.

Sixty-three specimens from Várerdő Hill, 189 from Szépvölgy, 90 from Martinovics Hill, 12 from Vár Hill and 16 from Németvölgyi road were examined.

1. Várerdő Hill at Solymár

Eocene and Oligocene deposits crop out in the valley of Jegenye Creek. The dateiled geological description is given by MONOSTORI (1967). *Nummulites – Discocyclina* limestone underlies the Oligocene Hárshegy Sandstone by angular unconformity *(Fig. 3)*.

According to KOCH (1872) the *Nummulites – Discocyclina* limestone can be divided into three parts, which are the following from the bottom to the top:

- *Nummulites* limestone
- sandy limestone
- *Discocyclina* limestone.

Thick strata of the light brown *Nummulites* limestone are cropping out at 7 m of thickness. The uppermost one metre is oolithic with fine lime mud matrix, carbonate content is 70-100 % (MONOSTORI, 1967).

This rock is rich in corraline algae, *Nummulites* and Miliolina species.

The dominant bivalve species are *Chlamys*, *Plicatula bovensis* DE GREGORIO and *Lentipecten corneus* (SOWERBY). *Spondylus* and *Ostrea* species are abundant as well. There are many Echinoidea in the upper part of *Nummulites* limestone. The most frequent species are *Echinanthus scutella* LAMARCK, *Echinolampas subsimilis* D'ARCHIAC and *Sismondia rosacea* LESKE.

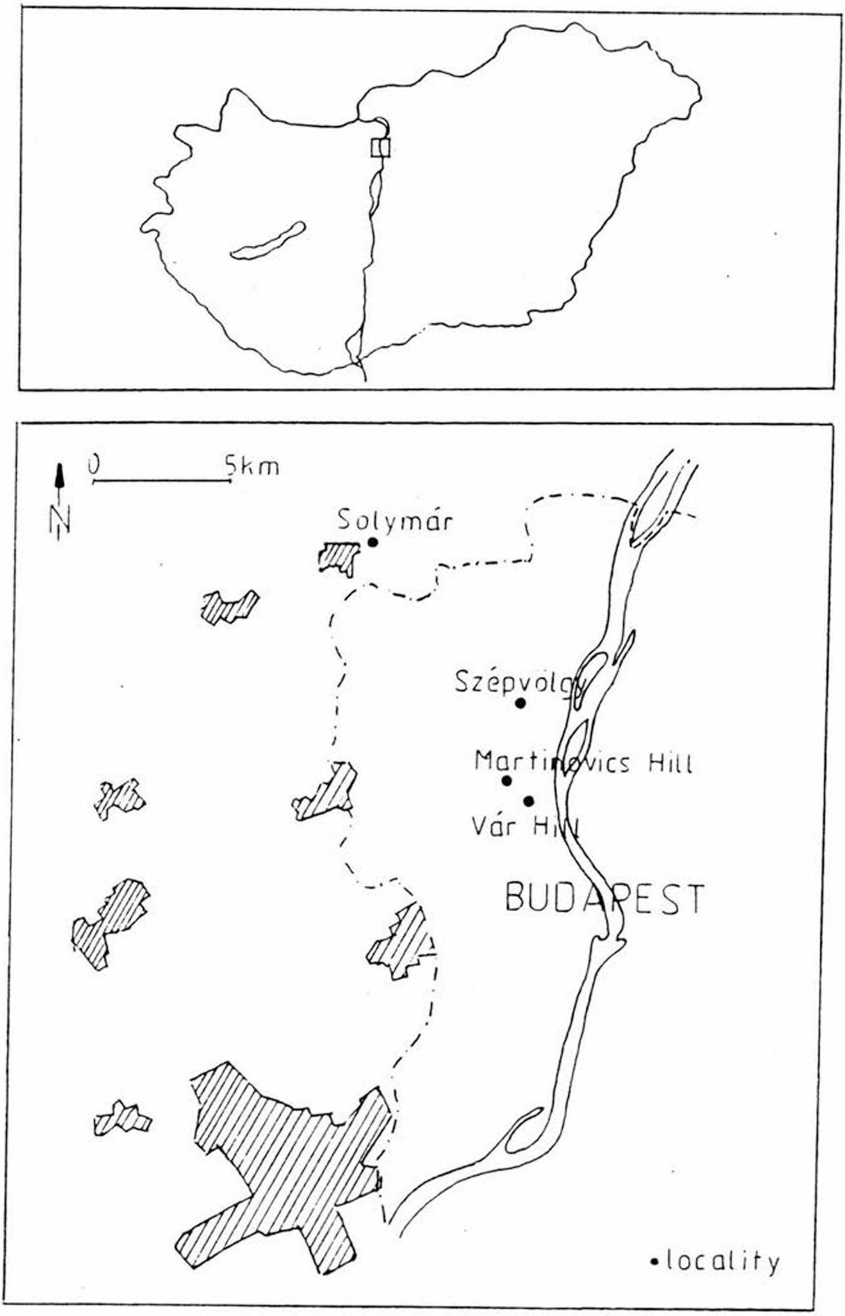

Fig. 1. Upper Eocene mollusc localities in Buda Mts.

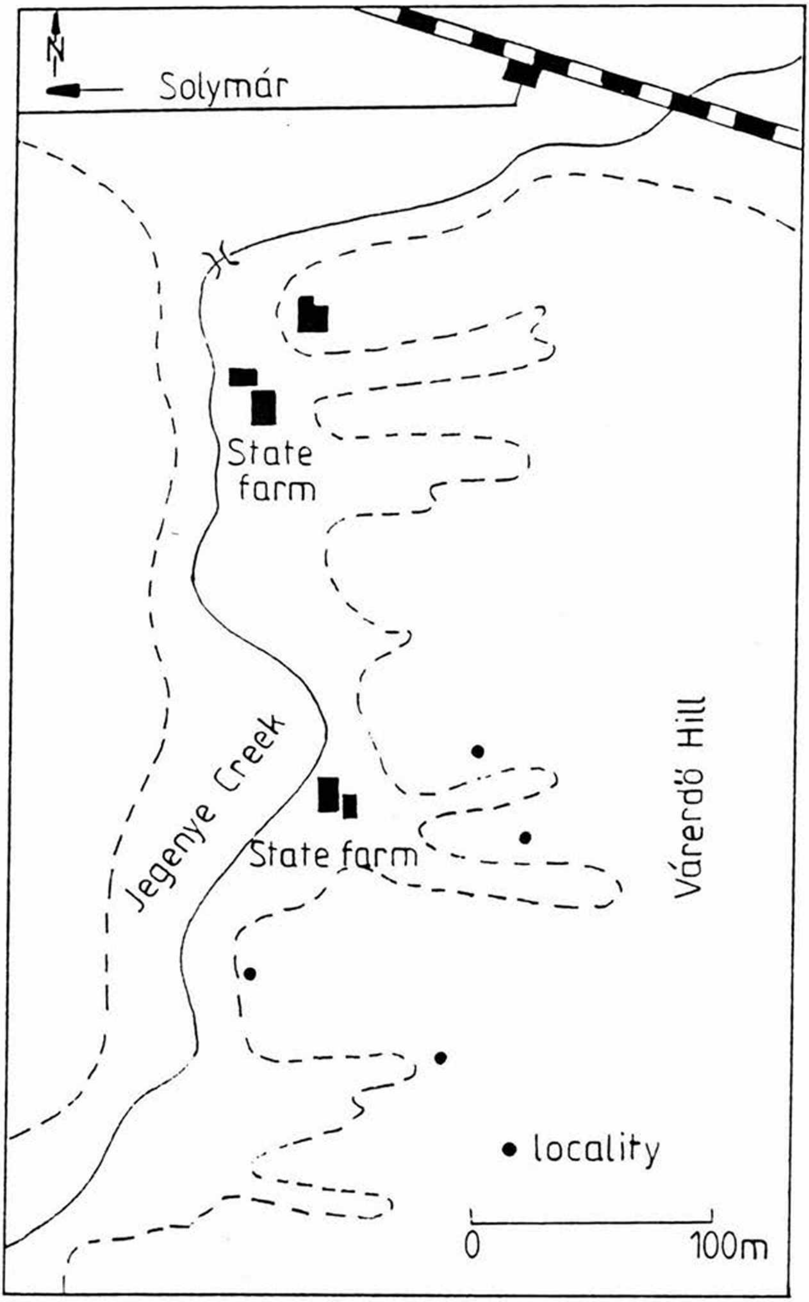

Fig. 2. Localities at Solymár, Várerdő Hill

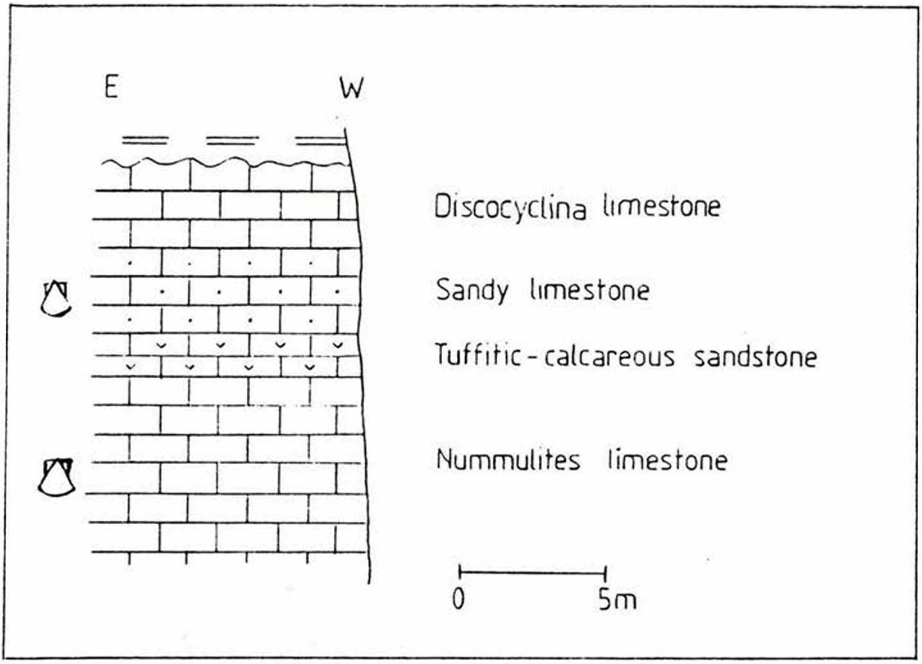

Fig. 3. Upper Eocene sequence at Solymár

The *Nummulites* limestone is gradually changed into the lilac - red, 6 m thick Sandy limestone, in which lime grains become dominant in red, argillaceous, calcareous muddy matrix. The carbonate content is 70 % (MONOSTORI, 1967).

Coralline algae are less important, while *Discocyclina* is more abundant.

More *Chlamys biarritzensis* (D'ARCHIAC) and *Plicatula bovensis* and more *Echinanthus scutella*, *Sismondia rosacea* and *Scutella tenera* LAUBE can be found.

The sandy limestone is followed by a 2-3 m thick, tabular *Discocyclina* limestone free of macrofossils.

2. Szépvölgy

The highest abundance of bivalves is in the Bryozoa Marl of Szépvölgy.

2.1 Western quarry of Mátyás Hill

It is in front of Pálvölgy Cave *(Fig. 4)*.
KÁZMÉR (1982) distinguished the following:

- *Orthophragmina* limestone (0-10 m)
- Calcareous *Actinocyclina* marl (10-13 m)
- Grey *Actinocyclina* marl (13-15 m)
- Bryozoan Marl (15-30 m) with an intercalation of quartzose sandstone (0.2 m)
- Buda Marl.

2.2 Eastern quarry of Mátyás Hill

This quarry is situated on the southern slope of the hill, near to Mátyáshegy and Kolostor streets.
MONOSTORI (1965) described the following units upward:

- limestone with coralline algae
- *Discocyclina* limestone
- Bryozoan Marl.

2.3 Outcrop at Erdeilak Restaurant

The Bryozoan Marl crops out 100 m westward from the restaurant.

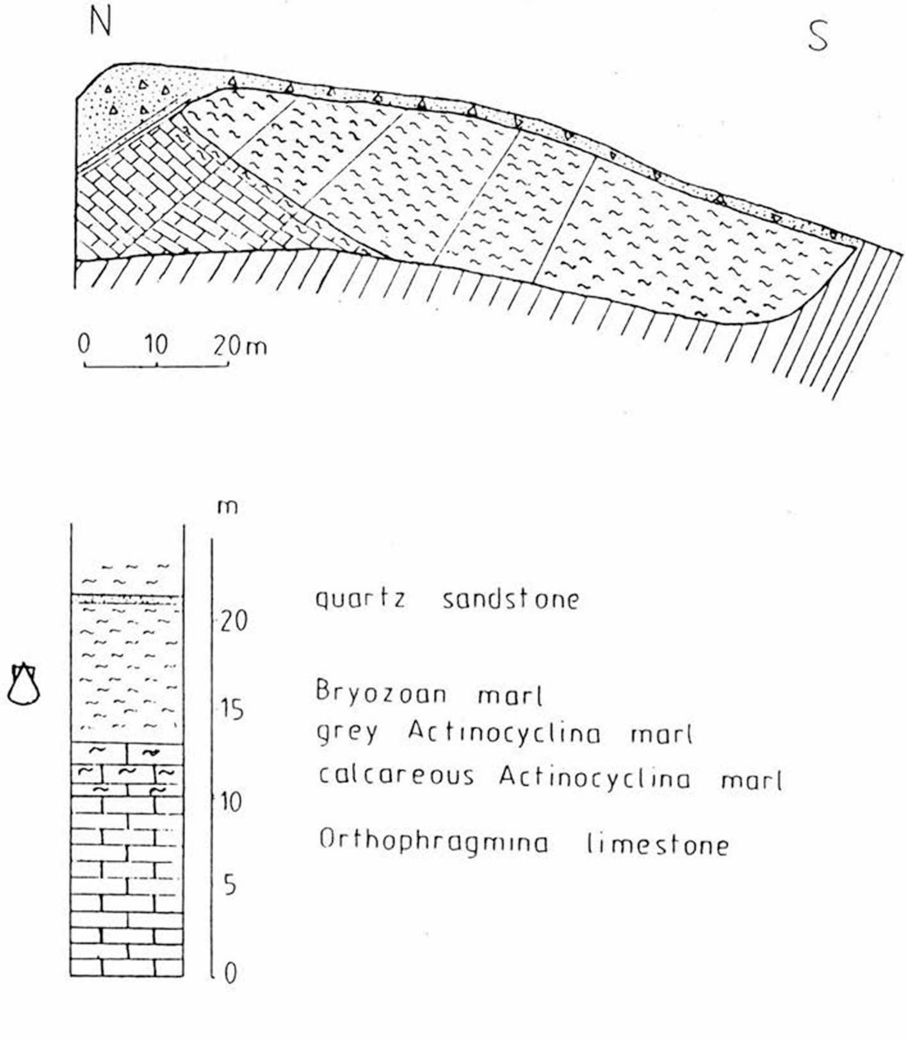

Fig. 4. Mátyás Hill, western quarry. Sequence after KÁZMÉR, 1982.

In this three last localities the Bryozoa Marl contained the bivalve fauna. The light grey, silty marl is rich in fossils. The dominant foraminifer genera are *Actinocyclina* and *Discocycllina*. Bryozoa are rock-forming. The 75 % of the bivalve fauna is *Chlamys biarritzensis*. From the rich Echinoidea assemblage *Schizaster lorioli* PÁVAY and *Opissaster szecsenyii* (PÁVAY) are the most frequent species.

Considerable part of the specimens were gathered from presently unknown outcrops of Martinovcs Hill, Vár Hill and Németvölgy road.

3. Martinovics Hill

Ninety specimens were collected from the *Nummulites - Discocyclina* limestone. Although this assemblage is smaller in abundance, it is greater in number of species. The 90 specimens belong to 10 species.

4., 5. Vár Hill and Németvölgy road

Twelve individuals from Vár Hill and sixteen from Németvölgy road were collected in the Buda Marl form house foundations.

General character of the bivalve fauna

The 370 specimens of this bivalve fauna belong to 21 species of 15 genera. Moulds and embedded shells made the determination more difficult, therefore the internal morphological features could not be studied. Many shells were etched so the external ornaments were missing. Due to the bad preservation 130 specimens were ranged only into genera.

Our determinations are in good agreement with the system of Treatise (MOORE, 1969). Table 1. contains the complete fauna list.

Table 1. Complete list of the studied fauna

Phylum Mollusca
- Calssis Bivalvia LINNÉ, 1758
  - Subclassis Pteriamorphia BEURLEN, 1944
    - Ordo Arcoida STOLICZKA, 1871
      - Superfamilia Limopsacea DALL, 1895
        - Familia Glycymerididae NEWTON, 1922
          - Subfamilia Glycymeridinae NEWTON, 1922
            - Genus *Glycymeris* DA COSTA, 1778

Glycycmeris sp.

Ordo Mytiloida FÉRUSSAC, 1822
Superfamilia Mytilacea REFINESQUE, 1815
Familia Mytilidae RAFINESQUE, 1815
Subfamilia Lithophaginae ADAMS and ADAMS, 1857
Genus *Lithophaga RÖDING, 1798*

Lithophaga zignoi (OPPENHEIM), 1900-1901

Subfamilia Modiolinae KEEN, 1958
Genus *Modiolus* LAMARCK, 1799

Modiola modioloides (BELLARDI), 1852
Modiola cf. *subcarinata* LAMARCK, 1806

Superfamilia Pinnacea LEACH, 1819
Familia Pinnidae LEACH, 1819
Genus *Pinna* LINNÉ, 1758

Pinna cf. *margaritacea* LAMARCK,

Ordo Pterioida NEWELL, 1965
Subordo Pteriina NEWELL, 1965
Superfamilia Pectinacea RAFINESQUE, 1815
Familia Pectinidae RAFINESQUE, 1815
Genus *Lentipecten* MARWICK, 1928

Lentipecten corneus (SOWERBY), 1821

Genus *Propeamussium* DE GREGORIO, 1884

Propeamussium semiradiatus (MAYER), 1861
Parvamussium fallax (KOROBKOV), 1939

Genus *Chlamys* RÖDING, 1798

Chlamys biarritzensis (D'ARCHIAC), 1847
Chlamys aff. *multicarinata* (DESHAYES), 1824
Chlamys subdiscors (D'ARCHIAC), 1847

Familia Spondylidae GRAY, 1826
Genus *Spondylus* LINNÉ, 1758

Spondylus bifrons MÜNSTER, 1840
Spondylus buchi PHILIPPI, 1847
Spondylus cf. *cisalpinus* BRONGNIART, 1823
Spondylus radula LAMARCK, 1806

Familia Plicatulidae WATSON, 1930
Genus *Plicatula* LAMARCK, 1801

Plicatula bovensis DE GREGORIO, 1894

Subordo Ostreina FÉRUSSAC, 1822
Superfamilia Ostreacea RAFINESQUE, 1815
Familia Grypheidea VYALOV, 1936
Subfamilia Pycnodonteinae STENZEL, 1959
Genus *Pycnodonta fischer* DE WALDHEIM, 1835

Pycnodonta brongniarti (BRONN), 1831

Familia Ostreidae LAMARCK, 1818
Subfamilia Ostreinae RAFINESQUE, 1815
Genus *Cubitostrea* SACCO, 1897

Cubitostrea cf. *plicata* SOLANDER,

Subfamilia Lophinae VYALOV, 1936
Genus *Lopha* BOLTEN in RÖDING, 1798

Lopha martinsi (D'ARCHIAC), 1848

Classis Heterodonta NEUMAYR, 1884
Ordo Veneroida ADAMS and ADAMS, 1856
Superfamilia Lucinacea FLEMING, 1828
Familia Lucinidea FLEMING, 1828
Subfamilia Lucininae FLEMING, 1828
Genus Lucina BRUGUIÈRE, 1797

Lucina sp.

Superfamilia Carditacea FLEMING, 1820
Familia Carditidae FLEMING, 1828
Subfamilia Carditesiane CHAVAN, 1966
Genus *Cardites* LINK, 1807

Cardites sp.

Superfamilia Crassatellacea FÉRUSSAC, 1822
Familia Crassatellidae FÉRUSSAC, 1822
Subfamilia Crassatellinae FÉRUSSAC, 1822
Genus *Crassatella* LAMARCK, 1799

Crassatella curata DESHAYES,
Crassatella subtumida BELLARDI, 1852

Subclassic Anomalodesmata DALL, 1889
Ordo Pholadomyoida NEWELL, 1965
Superfamilia Pholadomyacea GRAY, 1847
Familia Pholadomyidae GRAY, 1847
Genus *Pholadomya* SOWERBY, 1823

Pholadomya loczyi TAEGER, 1909

Biostratigraphy

For drawing biostratigraphical conclusions in the Late Eocene, plankton foraminifer and nannoplankton assembalges are more suitable than bivalves. The nannoplankton studies were carried out by BÁLDI-BEKE (1970).

Buda Marl containing *Variamussium fallax* is comparable with *Variamussium fallax* zone of Late Eocene described by Soviet stratigraphiers.

The presence of this species let more precise correspondence between Paleogene of Buda and Crimea, Caucasus and Rhodope regions (BÁLDI, 1983).

The great bulk of bivalves from Buda Hills indicate Late Eocene, but some of them existed in Middle Eocene or in Oligocene as well. Species confining only to the Middle Eocene or the Oligocene were not indentified.

Ranges of identified species are shown in *Table 2*.

Table 2. Ranges of identified species

	E_2	E_3	Ol_1
Chlamys biarritzensis (D'ARCH.)		x	x
Chlamys subdiscors (D'ARCH.)	x	x	x
Crassatella curata DESH.	x	x	
Crassatella subtumida BELL.	x	x	
Cubitostrea cf. *plicata* SOL.	x	x	
Lentipecten corneus (SOW.)	x	x	x
Lithophaga zignoi (OPP.)		x	
Lopha martinsi (D'ARCH.)	x	x	x
Modiola modioloides (BELL.)		x	
Modiola cf. *subcarinata* LAM.	x	x	
Parvamussium fallax (KOR.)	x	x	x
Pholadomya loczyi TAEG.	x	x	
Pinna cf. *margaritacea* LAM.	x	x	
Plicatula bovensis DE GREG.		x	
Propeamussium semiradiatus (MAY.)		x	x
Pycnodonta brongniarti (BRONN)	x	x	x
Spondylus bifrons MÜNST.	x	x	x
Spondylus buchi PHIL.	x	x	x
Spondylus cf. *cisalpinus* BRONGN.	x	x	x
Spondylus radula LAM.	x	x	

Palaeobiogeography

Twenty one species of the studied fauna were suitable for palaeobiogeographical reconstruction. There were only few comparable assemblages elaborated from different points of view or show different ecological or stratigraphical features, so the reconstruction was difficult to do. Statistical evaluation could not be carried out, as well.

Monographs with comparable faunal assemblages are only about the Transylvanian (MÉSZÁROS, 1957), Priabonian (PICCOLI et MOCELLIN, 1962) and Biarritzian (BOUSSAC, 1911) Late Eocene mollucs.

Taking into consideration the number of species in common of these four localities *(Table 3)*, preliminary conclusions could be done.

This study, corresponding to KECSKEMÉTI (1980), proves that our bivalve assemblage belongs to the Mediterranean province.

Table 3. Number of species in common

	Number of species	Number of species in common
Buda Hills	21	–
Priabona	62	12
Transylvania	65	11
Biarritz	34	5

After Piccoli et Mocellin, 1962 ; Mészáros 1957; Boussac, 1911.

Palaeoecology

Study of fossils is useful in reconstruction of palaeoenvironments as well as in drawing conclusions about the conditions of sedimentation. In addition we can get information about the habitat of animals from the characters of sediments (AGER, 1963). In this paper both methods were used.

Studying the recent environmental circumstances: water depth, quality of sediments, temperature, salinity and hydrodynamics, we can draw conclusions about ancient life. It made the actualistic evaluations easy that 13 from the 15 identified genera are still living in the seas.

Our knowledge of the recent life is due to the excellent description of DAVITASHVILI and MERKLIN (1966). Not only the environmental demands of recent forms, but also the sedimentological and palaeontological data were taken into consideration.

Fig. 5. shows the distribution of the characteristic bivalve genera of the main rock types. *Chlamys* is the dominant genus in *Nummulites* and sandy limestones of Solymár, in *Nummulites – Discocyclina* limestone and Bryozoan Marl. In the Buda Marl the most abundant genus is *Propeamussium*.

The palaeoecological conclusions were taken concerning the different abundance and number of species in the five rock types *(Table 4)*.

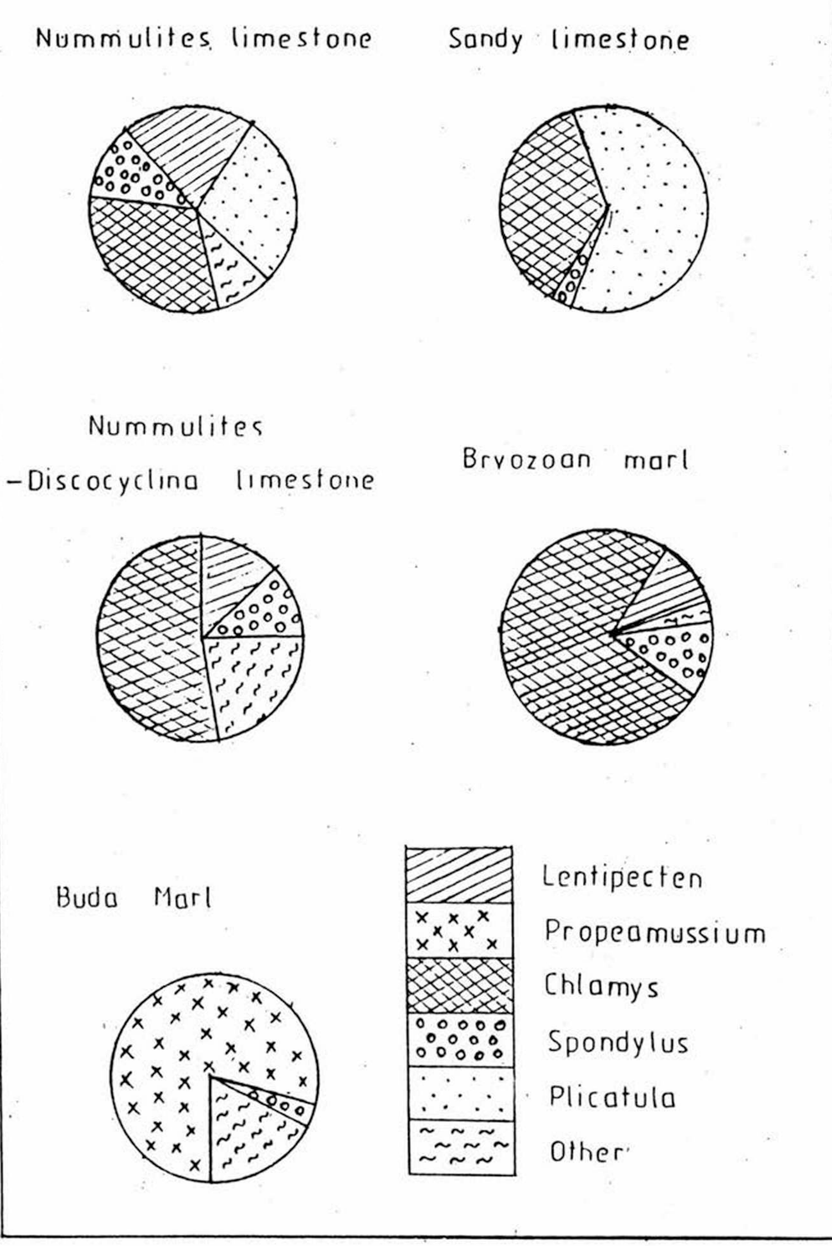

Fig. 5. Distribution of 6 bivalve genera in 5 types of rock.

Table 4. Occurrences of species in the five rock types

	A	B	C	D	E
Cardita sp.			x		
Chlamys biarritzensis (D'ARCH.)	x	x	x	x	
Chlamys aff. *multicarinata* (DESH.)	x				
Chlamys subdiscors (D'ARCH.)			x		
Chlamys sp.	x	x	x	x	
Crassatella curate DESH.			x		
Crassatella subtumida BELL.			x		
Cubitostrea cf. *plicata* SOL.			x		
Glycymeris sp.					x
Lentipecten corneus (SOW.)	x			x	x
Lithophaga zignoi (OPP.)			x		
Lopha martinsi (D'ARCH.)			x		
Lucina sp.			x		
Modiola modioloides (BELL.)				x	
Modiola cf. *subcarinata* LAM.			x	x	
Parvamussium fallax (KOR.)					x
Pholadomya loczyi TAEG.					x
Pinna cf. *margaritacea* LAM.				x	
Plicatula bovensis DE GREG.	x	x			
Propeamussium semiradiatus (MAY.)					x
Pycnodonta brongniarti (BRONN)	x			x	
Spondylus bifrons MÜNST.				x	
Spondylus buchi PHIL.			x		
Spondylus cf. *cisalpinus* BRONGN.					x
Spondylus radula LAM.	x	x	x	x	

A *Nummulites* limestone
B Sandy marl
C *Nummulites-Discocyclina* limestone
D Bryozoan marl
E Buda Marl

1. *Nummulites limestone*

Besides the dominant *Chlamys, Picatula bovensis* and *Lentipecten corneus, Spondylus* and *Ostrea* are also very frequent. Recent *Chlamys* species live in warm, shallow water attached by byssal threads to the sandy bottom or swin free. *Lentipectens* with smooth, flat shells is supposed to have lived in crevices in still water. Thick shells of *Ostrea* and spines of *Spondylus* indicate currents in the shallow water.

2. *Sandy limestone*

While *Plicatula bovensis* and *Chlamys* are very frequent, *Lentipecten corneus* is absolutely missing in this rock type. Although the bivalve fauna of *Nummulites* limestone and sandy limestone differ from each other, significant differences in the environmental conditions cannot be recognized.

3. *Nummulites-Discocyclina limestone*

Although the fauna of this rock type is the richest, more than the half of the specimens are *Chlamys.*

The morphology of the depositional surface must have been variable. *Lucina* lived in the sandy mud of shoals. *Lithophaga* bored into calcareous formations with the aid of acid secretion. The mollusc was held in position by byssal threads attached to the side of the burrow. The modern *Cardita* is abundant on the sandy bottom, above 50 m, in strong currents. Cemented forms also occur (eg.: *Spondylus*). According to recent examples this fauna lived on the sandy or muddy bottom, deeper than the wave base, but in maximum depth of 60 m, in warm water of normal salinity.

4. *Bryozoan marl*

Chlamys biarritzensis gives the 75 % of this assemblage. The remaining specimens are mostly *Spondylus* or *Lentipecten corneus.*

These genera refer to a wide range of water depths. Modern *Chlamys* species points to 1-90 m of depth. *Pinna* occurs from 30 to 300 m, in the soft, fine sand. *Pinna* is partly buried in sea bottom with pointed anterior end lowermost, attached by byssus to rocks or other objects in the sediment.

Spondylus appear even beneath 200 m, while *Modiola* lives between littoral and pelagic zones.

Interpreting this palaeocommunity we can suppose that Bryozoan Marl was deposited in approximately 100 m of warm, normal salinity water.

5. *Buda Marl*

The fauna gathered from Buda Marl indicates the deepest environment. *Amussium*, preferring deep, still water substitutes *Chlamys*, which dominates the previous rocktype. The attending *Glycymeris* and *Pholadomya* refer to deep water, too. In addition the lack of spines and ribs on shells points to deep, still water. Buda Marl may have been deposited in few hundred metres of depth.

In this sequence the bivalve assemblage indicate the deepening sea. The bottom sediments become finer from sand to mud.

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